

**AUTUMN AND SPRING IN THE LIFE OF THE QUEEN
POLISTES ANNULARIS AND P. PALLIPES.**

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In the late summer, to be exact, on September 2, 1920, about fifty nests of *Polistes annularis* were examined in their tree-top sites, and all of them were so thickly covered with adult wasps that they were absolutely black. The wasps were not coming and going, as wasps do during their busy season; these were all waiting colonies, with no work to do, since all of the larvae had pupated and the cells were empty. What causes the *P. annularis* to stop work at this time? What is their calendar? Flowers for nectar still abound. There are many empty cells that could be tenanted; caterpillars for food, and rotten wood for building material are plentiful; but with all materials convenient and inviting to industry, this idleness settles upon them. Perhaps the advent of numerous new wasps, or the presence of males, or the cold nights, caused them to sense that further work would be a waste of effort. Perhaps too the old queens had by this time gone the way of the just, and perhaps those which were on the nest were insects other than workers. It may be that this idleness was merely a condition of males and females waiting for an opportunity to do their part in the perpetuation of the species.

All these points call for further study; but let me definitely record this much, that on September 2 all of the nests were black with wasps, and several nests that were knocked down had a few marginal cells capped, with the young wasps within and many empty cells. One nest which had the outside two rows of cells capped gave forth thirty-two adults, the last of the tribe, during the following week, and strange to say there was not a male among them. They were undoubtedly the queens, but I have even up to this date been unable to distinguish the queens from the workers by external appearance. Indeed there is so little difference in appearance between them that I have held the theory that the nests of *P. annularis* and *P. pallipes* give forth originally but the two sexes, male and female, at the end of the season, and that the young females that are fertilized become queens the next season, while those that are not fertilized die off, as do the males. The young that are born the following summer, having had no opportunity to meet the males, continue to live as workers. This whole situation as I found it would at least again indi-

cate that the males emerge before the females. The notes that follow seem to show that the host of waiting insects on the nests at the end of the season contain the potential queens waiting to be fertilized.

An examination on October 1 and 2 showed that many of the nests had been deserted; many too had been blown to the ground by the wind, but five nests, about one-fifth of the number examined, were still completely covered with adult wasps just as they had been at the visit a month earlier. This of course shows that at that time they were rapidly deserting the nests for hibernating places. It also shows that, for some unexplained reason, certain ones hung on as if for dear life until the season's last gun was fired.

Wishing to ascertain the numbers and sex of the members of these colonies, I swept the entire population of two nests into the net and individually examined them. One colony had sixty-five adults, all of them queens—not a male nor a frayed (old) worker among them! We had had two frosts that fall, probably sufficient to kill all but the queens.¹

If the males emerge early and await the queens and fertilize them on the nest, this is not the only time when some are fertilized, nor do the males die with the first cold of autumn, as the following notes made in October will show.

It has been a problem to learn just where mating occurs in *P. annularis*, especially in the light of the above observations, wherein I found that in those nests which still retained their populations the wasps were all queens. However, the wasps which were accidentally trapped in the screened porch on the hill one-half mile west gave some slight clue to their mating habits. Both sexes were there, and mating occurred frequently, in spite of the lateness of the season.²

For years I never saw an *annularis* nesting on the hill-top. On October 13, on the inside of the screened porch, about fifteen queens were seen, and throughout the day others were seen entering the small openings in the shanty. This of course shows that in the autumn when they seek places for hibernation they do

¹ Out of this population of queens, thirty-nine were preserved in fluid and examined later, when it was found that two were stylopized.

² Both males and females of *P. annularis* were also seen flying about the vegetation aimlessly and alone.

travel considerable distances. In this case, the nearest group of nests which I had with thorough search discovered, was at least half a mile distant, in the lowlands. The same explanation probably accounts for the large numbers seen in the rocks at Cliff Cave in the very early spring of 1915 as described in "Wasp Studies Afield." At that place, the west shore of a steep, rocky cliff comes to the water's edge, while the eastern shore of the Mississippi is typical bottom land, with many willow trees. Hence I have more recently been of the opinion that the many queens found at Cliff Cave among the rocky ledges during the hibernating season, and which disappeared as completely and mysteriously at the opening of the nesting season, had come from the willows on the opposite shore to hibernate, and returned to the willows in the spring to build their nests.

I know that these wasps hibernate here in the shanties on the hill-top because I found the *P. annularis* coming out on sunny days and rehibernating when cold evening approached. I have recorded elsewhere how on February 28 several thousand were seen flying low in the sunshine, and again gradually disappearing into their crevices as the evening chill approached. I have also mentioned elsewhere that *P. annularis* nests in moist, swampy areas. On February 28, the area was sufficiently dry for me to examine a portion of the woods that was under water almost every spring. This gave me an opportunity to examine about a dozen nests in the trees, and I was surprised to find them in a very good state of preservation, probably due to the mild winter. I mention this condition, because it has a very direct bearing on the problems that the observation has opened. On April 2 these were revisited, and several queens, from three to six, were found quietly resting on each nest. This indicated that after a winter's hibernation the insects had remembered their old home site and had returned to it. An analogous case was noticed by Sladen³ on the bumblebee, *Bombus lapidarius*. He writes: "In the middle of June, 1907, when driving along the road near Sandwich, my attention was arrested by about twenty *lapidarius* queens endeavouring to burrow into a grassy bank facing north, the area of which was only about thirty square yards. The opinion I formed of this strange behaviour of so many queens was that they had been hibernating in the bank and were endeavouring to return to their burrows in obedience to a strong homing instinct."

³ The Humble-Bee, p. 137. 1912.

On April 28 these nests were again examined, and in every case the old home of the last year was deserted and a little new nest was begun just a few inches away from the old one. In few cases the new nest was a few inches above and in the others they were just a few inches below. Each nest carried from three to five queens, and it seemed evident that all had shared in the founding of the nest, because the colonies all had a large number of cells for a date so early in the season; indeed the number of cells in this lot was 48, 80, 55, 82, 60 and 25. The last and smallest nest had only one queen upon it. At this date an examination of the nests made by *P. pallipes* showed that from 2 to 14 cells were in each home; one can readily account for the enormous number of cells in the *P. annularis* nests by attributing the work to the joint efforts of several queens. The papery structure was so thin, however, that from below we could see daylight shining through; it seems that the thick card-board roof usually present is made later with the aid of the workers or with the assistance of the larvae following their habitual practice of emptying their alimentary tract just before pupating and plastering it to the roofs of the cells, where it soon hardens and gives the roof additional strength. The cells were then only shallow cups, and each contained an egg, but in the four nests that could be closely examined, not one contained any of the jelloid substance described elsewhere for *pallipes* nests.

The next discovery regarding this interesting species was that the old nests from the previous year, which at the opening of spring were in an excellent state of preservation, plainly showed that parts of them were disappearing as the new nests near by were increasing. I naturally assumed that the material was being rechewed and utilized in the new nests. To ascertain if this was really done, and how, I carefully cut down the saplings on which the nests hung, ten or fifteen feet above the ground, and thrust them back into the moist earth; this brought the nests down almost to a level with the eye, so the wasps could be the more easily observed, provided they did not object to the slight change in their elevation. A heavy rain a few hours later caused the river to rise and flood this area, so it was impossible to follow up the observations.

My visit in early April found *P. pallipes* still scarce, yet a few were seen about certain buildings, doing nothing in particular, and escaping at my appearance, though I am not admitting that my appearance warranted such conduct. Nearly a month later,

however, on April 23, I saw about the various buildings about fifty wasps, each with a tiny nest. The weather at that time of year was, of course, variable; the sunshine in the afternoon became very warm, and the nights sharply chilly. During my two days' visit to the region at this time, the warm hours were very few. Meanwhile all of these new builders crouched behind their nests, very sluggish with the cold, but, judging from the size of the nests, some of them must have been very active during the few warm days just preceding. These fifty nests each had from five to fourteen cells, and almost every cell contained an egg.

In *P. annularis* at the beginning of the season I noted several queens reigning on one nest. In this spring population of *P. pallipes*, I did not find more than one queen on a single nest.⁴ I happened to be nearby when one lone female, wandering about homeless, tried to alight when one nest of a companion, but was very promptly put to rout. When queen *P. pallipes* are lost in homing flights it sometimes happens that a homeless queen comes along and adopts the nest. In June, 1922, out of eighteen such unfortunate nests, three eventually were adopted by new mothers. These new queens in turn were taken on flights and lost. One nest in a conspicuous spot in the shelter-house enjoyed the attention of three new queens in succession; one other in an equally favored place had two adopted queens, and the other had only one foster-mother. This shows that they can adapt themselves to new and advantageous conditions in preference to laboriously starting a new colony so late in the season when they have lost their own home. It also indicates that those orphan nests which are more conspicuously located have the advantage in securing new mothers.

Noting that *P. pallipes* nests only in certain buildings and certain portions of such buildings, I thought that possibly the mothers were attracted to these places because of the old nests *per se*, so I distributed several *pallipes* nests, which had been gathered elsewhere, in certain sheds where *pallipes* were building, and in other sheds where they did not occur. These were pinned to position, and made to look as natural as possible. The result was that not one new nest was found about these substitute nests. Then again, many nests were confiscated for experimental purposes before they could give forth their queens, and in each and every instance, in the following spring no nests were to be

⁴ Three exceptions are described previously.

found near their places. On the other hand, wherever the colony was permitted to complete its life cycle in 1920, we found in the spring of 1921 a tiny new nest just a few inches away from the large one of the previous year. As additional evidence on this point, an accident gave further proof that certain individuals remember the spot where they were born and return to it to build their own nest, even though they hibernate at some distant place. Among the buildings on the hill-top, in the winter of 1920, I gathered abandoned nests of three colonies that I had observed the year before. Each site was marked, for my own convenience, with a large chalk mark on the wall or roof near the point of attachment. In April of the following spring, I found a nest in each of the three marked places, attached to the identical spot where the old nest had stood. Since there were thousands of square feet of sheltered space in this barn, and since the wasps utterly ignored other paper nests pinned on the walls, we can only suspect that the queens had remembered their old homesteads, aided possibly by the landmarks of chalk.

The question at once arises, how can dissemination occur if the new nests are built each spring near the old ones? But it does occur somehow, as was logically demonstrated by the following observation. In a small shed in a grain field of about three hundred acres, the only shed in a much larger area, I found a dozen nests in 1920. These were all confiscated for experimental purposes before any of the queens had come to maturity; hence this shed, which for four years had boasted from six to twelve *pallipes* nests, was now completely depopulated, and any wasps making their abode here in 1921 must be newcomers from colonies elsewhere. On April 28, 1921, we found here four small nests of *pallipes*, but not one of them chanced to be near the marks which still indicated the position of the last year's nests. This shows of course that not all queens can go back to the old homestead to build their new homes, but we do see a certain number of them remembering their old home, and—the more remarkable—doing so after a lapse say of five or six months, and others disseminating, accidentally or otherwise, arriving at a good home.